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SITE SPECIFIC RISK ASSESSMENT WORK PLAN FOR BUILDINGS 2009, 2009A, 2009B, 2009C AND 2009D DEFENSE REUTILIZATION AND MARKETING OFFICE NAVAL ACTIVITY PUERTO RICO
1/1/2006
AGVIQ/CH2M HILL

001617

Site-Specific Risk Assessment Work Plan

Buildings 2009, 2009A, 2009B, 2009C, and 2009D

Defense Reutilization and Marketing Office

U.S. Naval Activity Puerto Rico

Ceiba, Puerto Rico

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Atlantic

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Prepared by

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Contents

List of Exhibits

Acronyms

bgs	Below ground surface
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
COPC	chemical of potential concern
CSM	conceptual site model
CT	Central Tendency
DRMO	Defense Reutilization and Marketing Office
DRO	diesel range organics
EQB	Puerto Rico Environmental Quality Board
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
FACLANT	Naval Facilities Engineering Command, Atlantic
ft	foot/feet
HHRA	human health risk assessment
HI	Hazard Index
HQ	Hazard Quotient
IRIS	Integrated Risk Information System
JV I	AGVIQ-CH2M HILL Joint Venture I
mg/kg	milligrams per kilogram
NAPR	U.S. Naval Activity Puerto Rico
NTR	Navy Technical Representative
RAWP	Risk Assessment Work Plan
RBC	risk-based concentration
RME	Reasonable Maximum Exposure
SAP	Sampling and Analysis Plan
TRPH	total recoverable petroleum hydrocarbons

SECTION 1

Introduction

The sampling and analysis results for the 2005 closure investigation of Buildings 2009, 2009A, 2009B, 2009C, and 2009D conducted by AGVIQ-CH2M HILL Joint Venture I (JV I) at the Defense Reutilization and Marketing Office (DRMO) facility at Naval Activity Puerto Rico (NAPR) indicated that the closure standards for arsenic and total recoverable petroleum hydrocarbons (TRPH) were not met. Specifically, the arsenic levels found in the soil samples collected from the areas underlying and surrounding the buildings exceeded the arsenic closure standard (background level), as well as the U.S. Environmental Protection Agency (EPA) Region III Risk Based Concentration (RBC) for arsenic. The TRPH levels also exceeded the TRPH closure standard. In addition, both arsenic and TRPH were detected in the concrete samples collected from the floor of Building 2009 at levels exceeding their respective closure standards. Buildings 2009A, 2009B, 2009C, and 2009D (which were portable steel buildings specifically designed for flammable material storage) were decontaminated, demolished, and disposed of offsite in Class I landfills, and no concrete floor samples were collected from these buildings because the floor was constructed of steel.

The above-referenced sampling and analytical results were presented in the following reports:

- *Closure Sampling Report, Building 2009, Defense Reutilization and Marketing Office, U.S. Naval Activity Puerto Rico* (JV1, 2005a)
- *Closure Sampling Report, Building 2009A, Defense Reutilization and Marketing Office, U.S. Naval Activity Puerto Rico* (JV1, 2005b)
- *Closure Sampling Report, Buildings 2009B, 2009C, and 2009D, Defense Reutilization and Marketing Office, U.S. Naval Activity Puerto Rico* (JV1, 2005c)

EPA and the Puerto Rico Environmental Quality Board (EQB) submitted comments (dated September 27, 2005) on the above-referenced Closure Sampling Reports. The comments included the following:

- Approval of the recommendation included in the reports to conduct additional background soil sampling to establish a new background arsenic concentration that is more representative of either natural conditions, or non-waste-related, anthropogenic activities at NAPR.
- Requirement to conduct additional soil sampling in the vicinity of Building 2009 to more fully delineate the nature and extent of elevated TRPH levels.
- Approval of the recommendation to perform a site-specific human health risk assessment (HHRA) of the approximate 0.25-acre area that encompasses Building 2009 and former Buildings 2009A, 2009B, 2009C, and 2009D to address the arsenic-impacted and TRPH-impacted soils, if appropriate, following determination of the new soil background arsenic level and the full nature and extent of TRPH-impacted soils. The HHRA will also address the arsenic and TRPH detected in the concrete floor samples collected in Building 2009.

Once the new arsenic background level is established for site soils and the full extent of the TRPH-impacted soils in the vicinity of Building 2009 is assessed, the soil analytical data for Buildings 2009, 2009A, 2009B, 2009C, and 2009D will be re-evaluated for compliance with the arsenic and TRPH closure standards (including the new background level for arsenic). This evaluation will be conducted using the same statistical analysis methodology described in the *Site Specific Sampling and Analysis Plan, Building 2009* (JV I, 2005d). Additionally, the range of concentrations detected in site samples will be compared against the range of concentrations detected in background samples to determine if the differences are significant. Statistical methods described in EPA guidance will also be used to determine if the site samples indicate significantly elevated concentrations.

The sampling and analysis plan (SAP), which describes the supplemental (Phase II) closure sampling and analysis to be conducted to establish the new background soil arsenic level and to delineate the TRPH-impacted soil in the vicinity of Building 2009, is provided under separate cover.

If the evaluation of the additional soil sampling results indicates that the closure standards for arsenic or TRPH are not met, then a site-specific HHRA will be conducted to address arsenic or TRPH in site soils and the concrete floor samples in Building 2009. On the other hand, if the evaluation of the additional sampling results indicates that the closure standards for site soils are met, then the site-specific HHRA will only address the detected levels of arsenic and TRPH in the concrete floor samples in Building 2009.

This Site-Specific Risk Assessment Work Plan (RAWP) presents the work elements of the proposed HHRA activities for the approximate 0.25-acre area encompassing Building 2009 and former Buildings 2009A, 2009B, 2009C, and 2009D, and assumes that the HHRA will address site soils, in addition to the concrete flooring of Building 2009.

The remaining sections of this RAWP are organized as follows:

Section 2, Selection of Chemicals of Potential Concern - Describes the procedures for identifying the chemicals of potential concern (COPCs) to be addressed in the HHRA.

Section 3, Exposure Assessment – Describes the procedures for evaluating exposure pathways, identifying appropriate receptors, and selecting appropriate exposure-point concentrations (EPCs).

Section 4, Toxicity Assessment – Presents health effects summaries of the toxicity of the COPCs at the site, and summaries of quantitative indices of toxicity for non-carcinogenic and carcinogenic effects.

Section 5, Risk Characterization – Describes the process for process for estimating the magnitude of potential adverse health effects from exposure to COPCs.

Section 6, Uncertainty Characterization – Provides a discussion of the uncertainties associated with the HHRA.

Section 7, Project Organization – Identifies key project team members and contact information.

Section 8, References – Lists documents cited in this RAWP.

SECTION 2

Selection of Chemicals of Potential Concern

The levels of arsenic and TRPH detected in the concrete core samples collected from the floor of Building 2009 exceed closure standards, and are therefore COPCs for concrete dust. As previously described, additional background soil samples for arsenic will be collected to determine a more representative soil background concentration for arsenic. With regard to TRPH, additional soil samples will be collected in the vicinity of Building 2009 to more fully delineate the nature and extent of the TRPH-impacted soils in this area. The following sections describe the procedures for determining whether or not arsenic and TRPH will be selected as COPCs for site soils in the HHRA.

2.1 Approach for Arsenic in Soil

The *Phase II Closure Sampling and Analysis Plan* (JV I, 2006) describes the sampling and analysis to be conducted at NAPR to establish a new background arsenic concentration in soil that is more representative of either natural conditions, or non-waste-related, anthropogenic activities.

Once the new arsenic background level is established for site soils, all of the arsenic soil sampling data for Buildings 2009, 2009A, 2009B, 2009C, and 2009D will be evaluated together for compliance with the closure standard (background level or EPA Region III RBC (1.91 milligrams per kilogram [mg/kg], whichever is higher) using the same statistical analysis methodology described in the *Site-Specific Sampling and Analysis Plan, Building 2009* (JV I, 2005d). If the arsenic level in surface soil (0-2 feet [ft]) exceeds the closure standard, arsenic will be selected as a COPC to be addressed in the HHRA relative to site soils. However, if the arsenic level in soil does not exceed the closure standard, arsenic will not be identified as a COPC for site soil and potential exposures to arsenic in soil will not be quantified in the HHRA.

2.2 Approach for TRPH in Soil

The *Phase II Closure Sampling and Analysis Plan* (JV I, 2006) describes the soil sampling and analysis to be conducted near Building 2009 to delineate the elevated TRPH (Diesel Range Organics [DRO]) concentration in the vicinity of previous soil sample locations SB4, SB8, and SB10. The new TRPH (DRO) sampling data will be combined with the existing TRPH (DRO) soil sampling data for Buildings 2009, 2009A, 2009B, 2009C, and 2009D, and evaluated relative to the TRPH (DRO) closure standard of 100 mg/kg. The evaluation will be conducted using the same statistical analysis methodology described in the *Site-Specific Sampling and Analysis Plan, Building 2009* (JV I, 2005d).

If the TRPH (DRO) level in surface soil (0-2 ft) exceeds the closure standard, TRPH (DRO) will be selected as a COPC to be addressed in the HHRA relative to site soils. However, if the TRPH (DRO) level in the soil does not exceed the closure standard, TRPH (DRO) will not be identified as a COPC for site soil and potential exposures to TRPH (DRO) will not be quantified in the HHRA.

SECTION 3

Exposure Assessment

The exposure assessment will consist of two main steps:

1. Evaluating exposure pathways and identifying appropriate receptors
2. Selecting appropriate EPCs

Exhibit 3-1 presents a preliminary conceptual site model (CSM), which depicts the types of potential exposures to arsenic and TRPH at, or migrating from, the approximate 0.25-acre area encompassing Building 2009, and former Buildings 2009A, 2009B, 2009C, and 2009D (hereafter referred to as Building 2009 area). The CSM depicts the primary site source, potentially affected environmental media, chemical fate and transport mechanisms, potentially exposed receptors, and potential exposure pathways. The CSM summarizes existing site characterization data, including assumptions about land use and exposure. The preliminary CSM will be refined, if necessary, in the HHRA.

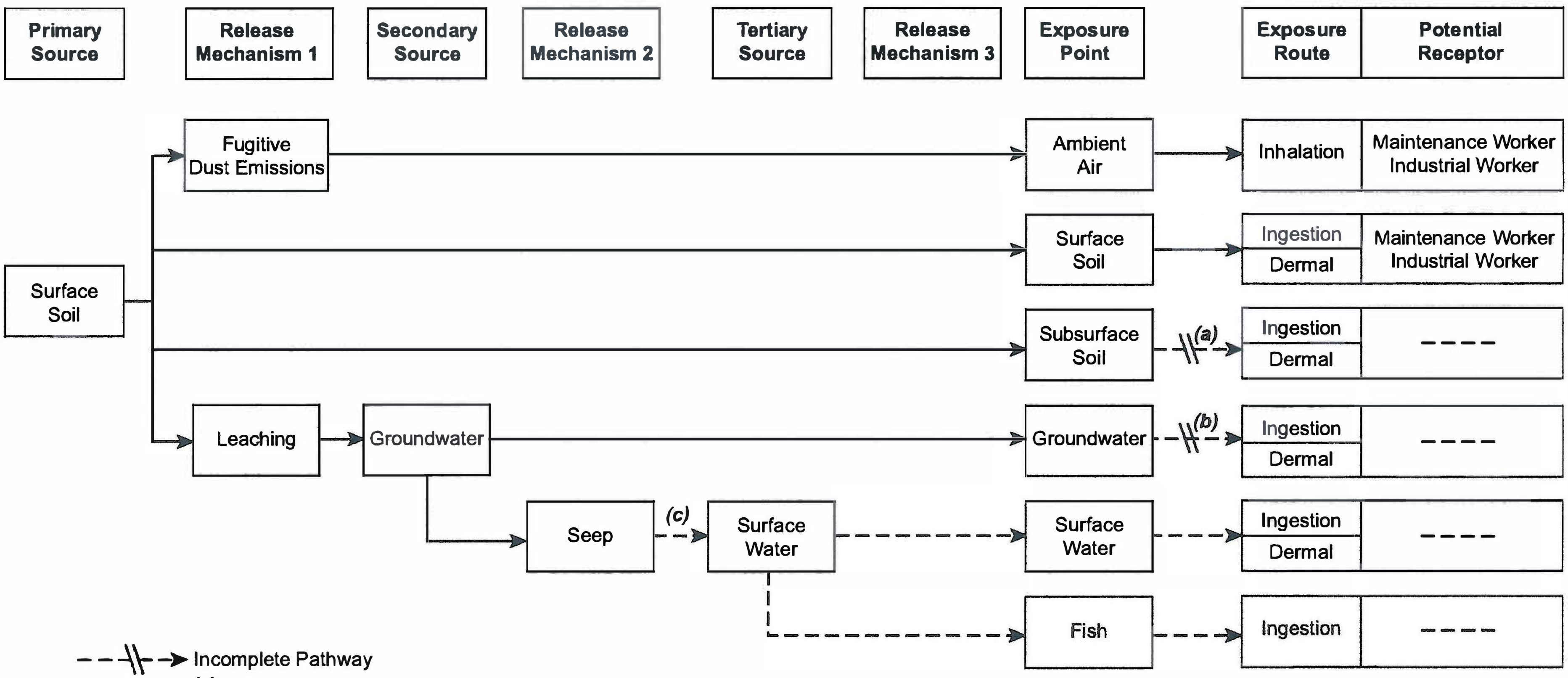
3.1 Evaluation of Exposure Pathways and Identification of Receptors

An exposure pathway evaluation describes how a receptor could be exposed to chemicals at, or migrating from, the Building 2009 area. A potentially complete exposure pathway consists of four necessary elements:

- A source and chemical release
- An environmental transport medium
- A point of potential contact with a receptor
- A feasible route of exposure at the exposure point

Potential groundwater exposures will not be evaluated in the HHRA. Direct contact exposures to groundwater are not expected to occur in the Building 2009 area in the future since uncontrolled deep excavation activities are not anticipated. The depth to groundwater at the DRMO site is approximately 20 ft or more below ground surface (bgs). Further, future use of groundwater at the site for potable or irrigation water is not expected because the area is already served by a reliable potable water supply.

The DRMO site has been inactive since 2004 and the site is currently abandoned with no current receptors at the site. Due to the remoteness of the site on the Base, trespassing is not expected. Given that the future land use of the Building 2009 area is assumed to be industrial, the likely receptors to be present in the Building 2009 area in the future are maintenance workers and industrial workers. The exposure pathways considered appropriate for these receptors are discussed in the following sections.



Incomplete Pathway

(a) No invasive activities below depth of 2 feet

Insignificant Pathway

(b) No potable use of groundwater

(c) Nearest surface water is over 4,000 feet from site and constituents of potential concern would not likely migrate to surface water due to biodegradation, adsorption, and dilution.

Subsurface Soil Soil below depth of 2 feet below ground surface

Exhibit 3-1

Preliminary Conceptual Site Model for Building 2009 Area

U.S. Naval Activity Puerto Rico

Ceiba, Puerto Rico

AGVIQ CH2M HILL

3.1.1 Future Maintenance Worker

Future maintenance workers may be engaged in landscape maintenance, pest control, and minor utility repair activities in the Building 2009 area, and could contact COPCs in surface soil (0-2 ft) through incidental ingestion, dermal contact, or inhalation of suspended particulates or volatile emissions.

Although some underground utilities at the DRMO facility are deeper than 2 ft bgs, any underground maintenance work on these utilities would be infrequent, no more than once or twice per year. In addition, the duration of the underground maintenance activities would be no longer than a few days, and such activities would likely be conducted by different maintenance workers each year. Consequently, there should not be any significant exposures to maintenance workers involved in the infrequent, short-term underground maintenance activities, if any.

Maintenance workers may also be engaged in building maintenance activities inside Building 2009, and exposures to COPCs contained in the dust eroding from the concrete floor may occur. The potential exposure pathways for arsenic and TRPH in dust from the concrete floor surface to workers are ingestion and dermal contact. Ingestion exposure could potentially result from skin contact with dust followed by hand-to-mouth contact through smoking or eating.

Inhalation exposures could potentially result from windblown dust, or mechanical suspension producing dust concentrations in air. However, inhalation of dust from the concrete floor surface is considered negligible since organic chemicals tend to volatilize from refined dust particles, and inorganic chemicals have a low tendency to be absorbed.

The following exposure pathways relative to site soils may be complete and will be evaluated for maintenance workers in the HHRA if COPCs are identified for soil: soil ingestion, dermal contact, and inhalation of ambient air. The exposure pathways that may be complete relative to the concrete floor dust in Building 2009 are dermal contact and incidental ingestion.

3.1.2 Future Industrial Worker

The soil in the Building 2009 area is partially covered with vegetation or paved with asphalt or concrete. Future industrial workers may contact COPCs in exposed surface soil (0-2 ft) through incidental ingestion, dermal contact, or inhalation of suspended particles or volatile emissions. Future industrial workers may also be engaged in work activities inside Building 2009, and exposures to COPCs in concrete dust may occur. The potential exposure pathways for arsenic and TRPH in concrete dust are ingestion and dermal contact. Ingestion exposure could potentially result from skin contact with dust followed by hand-to-mouth contact through smoking or eating.

Inhalation exposures could potentially result from windblown dust, or mechanical suspension producing dust concentrations in air. However, inhalation of dust from the concrete floor surface is considered negligible as organic chemicals tend to volatilize from refined dust particles, and inorganic chemicals have a low tendency to be absorbed.

The following exposure pathways relative to site soils may be complete and will be evaluated for industrial workers in the HHRA if COPCs are identified for soil: soil ingestion, dermal contact, and inhalation of ambient air. The exposure pathways that may be complete relative to the concrete floor dust in Building 2009 are dermal contact and incidental ingestion.

3.2 Selection of Exposure Point Concentrations

EPCs are the chemical concentrations in an environmental medium to which a receptor may be exposed at a specific location (the "exposure point"). EPCs can be based on analytical data obtained from onsite sampling or they may be estimated through modeling.

To assess potential exposures to COPCs at the Building 2009 area, EPCs will be calculated. EPA defines two types of exposure estimates: Reasonable Maximum Exposure (RME) and Central Tendency (CT), or average exposure. The EPCs used in the HHRA will be based on RME assumptions. The RME is defined as the highest exposure that could reasonably be expected to occur for a given exposure pathway at a site, and is intended to account for both uncertainty in the chemical concentration and for variability in the exposure parameters (such as exposure frequency or averaging time). The CT is evaluated for comparison purposes and generally is based on the arithmetic average exposure parameters. CT exposures will be quantified if RME risks exceed acceptable levels. The same EPCs will be used in both RME and CT calculations. However, less conservative exposure factors will be used in calculating CT intakes if CT exposures are quantified.

3.2.1 Soil

EPCs will be calculated for the COPCs (if any) in surface soil at the Building 2009 area. The EPA ProUCL tool will be used to develop the upper-bound estimate of the average concentrations in the exposure area.

3.2.2 Concrete Floor Dust

EPCs will be calculated for arsenic and TRPH in concrete core samples from Building 2009. The EPA ProUCL tool will be used to develop the upper-bound estimate of the average concentrations in the exposure area.

3.3 Intake Estimates

Intake variables (exposure factors) will be used to estimate COPC intakes by receptors relative to site soils (if quantified) and concrete floor dust in Building 2009. Exposure factors are often assumed values, and their magnitude affects the estimates of potential exposure. The applicability of the selected values contributes to uncertainty in the resulting intake estimates.

3.3.1 Soil

The exposure factors to be used to estimate chemical intakes and inhalation exposure concentrations associated with ingestion, dermal, and inhalation exposures to site soils are provided in Exhibit 3-2. The references cited in Exhibit 3-2 were used to identify pathway-specific intake factors for potential exposure pathways. Where appropriate, site-specific information was used to identify reasonable yet conservative exposure factors.

EXHIBIT 3-2
Exposure Factors For Soils
Building 2009 Area Risk Assessment Work Plan

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/Reference	Intake Equation/ Model Name
Ingestion	Maintenance Worker	Adult	Building 2009 Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1.RME	mg/kg	See Table 3.1.RME	CDI (mg/kg-day) = CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT
				IR-S	Ingestion Rate of Soil	100	mg/day	EPA, 1991	
				EF	Exposure Frequency	52	days/year	(1)	
				ED	Exposure Duration	25	years	EPA, 1991	
				CF1	Conversion Factor 1	0.000001	kg/mg	- -	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	
	Industrial Worker	Adult	Building 2009 Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1.RME	mg/kg	See Table 3.1.RME	CDI (mg/kg-day) = CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT
				IR-S	Ingestion Rate of Soil	100	mg/day	EPA, 1991	
				EF	Exposure Frequency	250	days/year	EPA, 1991	
				ED	Exposure Duration	25	years	EPA, 1991	
				CF1	Conversion Factor 1	0.000001	kg/mg	- -	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	
Dermal	Maintenance Worker	Adult	Building 2009 Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1.RME	mg/kg	See Table 3.1.RME	CDI (mg/kg-day) = CS x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				SA	Skin Surface Area Available for Contact	3,300	cm^2	EPA, 2004, (2)	
				SSAF	Soil to Skin Adherence Factor	0.2	mg/cm^2-day	EPA, 2004, (3)	
				DABS	Dermal Absorption Factor Solids	Chemical Specific	--	EPA, 2004	
				CF1	Conversion Factor 1	0.000001	kg/mg	- -	
				EF	Exposure Frequency	52	days/year	(1)	
				ED	Exposure Duration	25	years	EPA, 1991	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	
	Industrial Worker	Adult	Building 2009 Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1.RME	mg/kg	See Table 3.1.RME	CDI (mg/kg-day) = CS x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				SA	Skin Surface Area Available for Contact	3,300	cm^2	EPA, 2004, (2)	
				SSAF	Soil to Skin Adherence Factor	0.2	mg/cm^2-day	EPA, 2004, (3)	
				DABS	Dermal Absorption Factor Solids	Chemical Specific	--	EPA, 2004	
				CF1	Conversion Factor 1	0.000001	kg/mg	- -	
				EF	Exposure Frequency	250	days/year	EPA, 1991	
				ED	Exposure Duration	25	years	EPA, 1991	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	

EXHIBIT 3-2
Exposure Factors For Soils
Building 2009 Area Risk Assessment Work Plan

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/Reference	Intake Equation/ Model Name
Inhalation	Maintenance Worker	Adult	Emissions from Bldg 2009 Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1.RME	mg/kg	See Table 3.1.RME	CDI (mg/kg-day) = CA x IN x EF x ED x 1/BW x 1/AT CA (mg/m^3) = CS (1/PEF + 1/VF)
				CA	Chemical Concentration in Air	Calculated	mg/m^3	EPA, 2002	
				PEF	Particulate Emission Factor	1.36E+09	m^3/kg	EPA, 2002	
				VF	Volatilization Factor for volatile constituents	Calculated	m^3/kg	EPA, 2002	
				IN	Inhalation Rate	20	m^3/day	EPA, 1991	
				EF	Exposure Frequency	52	days/year	(1)	
				ED	Exposure Duration	25	years	EPA, 1991	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
	Industrial Worker	Adult	Emissions from Bldg 2009 Surface Soil	CS	Chemical Concentration in Soil	See Table 3.1.RME	mg/kg	See Table 3.1.RME	CDI (mg/kg-day) = CA x IN x EF x ED x 1/BW x 1/AT CA (mg/m^3) = CS (1/PEF + 1/VF)
				CA	Chemical Concentration in Air	Calculated	mg/m^3	EPA, 2002	
				PEF	Particulate Emission Factor	1.36E+09	m^3/kg	EPA, 2002	
				VF	Volatilization Factor for volatile constituents	Calculated	m^3/kg	EPA, 2002	
				IN	Inhalation Rate	20	m^3/day	EPA, 1991	
				EF	Exposure Frequency	250	days/year	EPA, 1991	
				ED	Exposure Duration	25	years	EPA, 1991	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	

Notes:
(1) Conservative assumption based on potential maintenance activities (e.g., lawn mowing) at the site, 2 days per week for 26 weeks.
(2) Worker assumed to wear a short-sleeved shirt, long pants, and shoes; therefore, the exposed surface area is the face, hands and forearms.
(3) SSAF based on maximum adherence factor for utility workers.
Sources:
EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.
EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.
EPA, 2004: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. EPA/540/R/99/005

When neither site-specific nor default values were available, professional judgment was used to develop exposure parameters.

3.3.2 Concrete Floor Dust

Existing published EPA guidance does not address exposure to concrete. However, some EPA Region III guidance exists for exposure to indoor dust from concrete or other solid surfaces of building interiors. Based on this guidance, the methods to be used to estimate chemical intake from dusts generated from the concrete floor in Building 2009 are described below.

Chemical intake is calculated as the product of the concentration in dust generated from concrete surfaces and an intake factor. The intake factor reflects assumptions describing rate of contact with TRPH and arsenic in dust, exposure frequency and duration, and body weight. With concentration in dust and intake factor, target risk can be calculated as follows:

$$TR = C_{dust} \sum_{n=1}^{i} (IF \times SF)_i$$

Where:

IF = intake factor (day^{-1})
C_{dust} = concentration in concrete dust (mg/kg)
SF = Cancer slope factor (1/(mg/kg/day))

Similarly, for exposure-related noncarcinogenic effects, the hazard index (HI) can be estimated from C_{dust} as follows:

$$HI = \frac{C_{dust} \sum_{n=1}^{i} IF_i}{\sum_{n=1}^{i} RfD_i}$$

IF = intake factor (day^{-1})
C_{dust} = concentration in concrete dust (mg/kg)
RfD = Reference dose (mg/kg/day)

The exposures are expected to occur primarily through dermal contact. The dust from hands may be ingested during the course of the work day. The intake factors for such a scenario are calculated as described below:

Dermal intake factor:

$$IF_{dermal} = \frac{SA \times AF \times 10^{-6} \, kg\,/\,mg \times ABSd \times FTSS \times EF \times ED}{BW \times AT \times 365 \; days\,/\,year}$$

Where:

SA = Exposed skin surface area (cm^2)
AF = Dust-to-skin adherence factor (quantity of dust adhering to the skin) (mg/cm^2)

ABS_d = Dermal absorption factor (chemical specific - unitless)
FTSS = Fraction transferred to skin from concrete surface (unitless)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (years)

From the amount of dust adhered to the skin, oral intake can be estimated as follows:

$$IF_{oral} = \frac{D_{dermal} \times FTSM \times ABSd \times EF \times ED}{BW \times AT \times 365\ days\ /\ year}$$

IF_{oral} - Intake factor –oral
D_{dermal} – deposited amount on the skin (mg)
FTSM – Fraction transferred from hands to mouth (unitless)
ABS_d = Dermal absorption factor (chemical specific - unitless)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (years)

The concrete core sample data will be used for the C_{dust} values, assuming dust will have similar concentrations as the concrete core samples. The dust generated from the floor itself is likely to be minimal, particularly because an epoxy coating covers the concrete floor surface; therefore, assuming similar concentrations is a conservative assumption.

The exposure factors to be used to estimate chemical intakes associated with dermal contact and ingestion exposures to concrete floor dust in Building 2009 are provided in Exhibit 3-3. The references cited in Exhibit 3-3 were used to identify pathway-specific intake factors for potential exposure pathways. Where appropriate, site-specific information was used to identify reasonable yet conservative exposure factors. When neither site-specific nor default values were available, professional judgment was used to develop exposure parameters.

EXHIBIT 3-3
Exposure Factors for Concrete Dust
Building 2009 Area Risk Assessment Work Plan

Exposure Parameters for Dust from Concrete				
Parameter Name	**Symbol**	**Value**	**Units**	**Comments**
Exposed skin surface area*	SA	420	cm^2	Source: EPA, 2004. Surface area of palms of hands.
Dust-to-skin adherence factor	AF	0.2	mg/cm^2	Source: EPA, 2004
Fraction transferred from surface to skin	FTSS	0.5	unitless	Only partial amount of dust present on surface adheres to the skin – based on best professional judgment. (per EPA Region III Wipe Sample Assessment)
Fraction transferred from hands to mouth	FTSM	0.1	unitless	10% of dust on the palms is assumed to be ingested during routine activities. (per EPA Region III Wipe Sample Assessment)
Dermal absorption factor	ABS_d-TRPH**	0.13	unitless	Source: EPA, 2004
Dermal absorption factor	ABS_d-Arsenic	0.03	unitless	Source: EPA, 2004
Exposure frequency	EF	250	days/year	Source: EPA, 1991. Based on 5 days per week.
Exposure duration	ED	25	years	Source: EPA, 1991. Cited as 90th percentile of tenure with a single employer.
Body weight	BW	70	kg	Source: EPA, 1991. Average adult body weight.
Averaging time	AT	70 or 25	years	Source: EPA, 1989. 70-year averaging time used to calculate *lifetime average daily dose* (LADD) for cancer risk. 25-year averaging time (same as exposure duration) used to calculate *average daily dose* (ADD) for non-cancer effects.

Note: *- The SA is estimated assuming palm and fingers come into contact with dust on the concrete surface on a daily basis. The skin surface of the hands is 840 cm^2; one-half of this skin surface (the palm and bottom surfaces of the fingers), or 420 cm^2 is assumed to come into contact with dust. One-half (50 percent) of the TRPH on the surface is assumed to be transferred to the skin. With these assumptions, it is assumed that an individual is continually absorbing TRPH through the skin of the hands from contact with dust.
** - TRPH absorption factors are based on the polycyclic aromatic hydrocarbon (PAH) ABS value

SECTION 4

Toxicity Assessment

The toxicity assessment will consist of two main steps:

1. Health effects summaries of COPC toxicity
2. Summaries of quantitative indices of toxicity for non-carcinogenic and carcinogenic effects

In the first step, brief toxicology summaries will be prepared for COPCs. These summaries will discuss qualitatively toxicokinetics and key adverse effects that could potentially result from exposure to COPCs. In the second step, EPA consensus toxicity values (e.g., reference doses [RfDs] and carcinogenic slope factors [SFs]) will be identified for use in the HHRA. The Integrated Risk Information System (IRIS) database available on-line (EPA, 2005) provides up-to-date toxicity and dose-response information for arsenic.

The analytical results from the soil and concrete samples indicated the absence of volatile aromatic hydrocarbons at the site (e.g., benzene, toluene, ethyl benzene, xylenes). Due to absence of volatile fractions, and age of the potential spills/releases at the site, it is assumed that TRPH compounds detected at the site are likely to be slower degrading heavier hydrocarbon fractions. The polycyclic aromatic hydrocarbons (PAHs) detected in the site samples were mostly below health-based RBC levels, thus the hydrocarbons reported in the site samples are likely to be from straight chain hydrocarbons. The RfD for the medium range hydrocarbons (C9-C18) ranges from 0.1 to 0.6 mg/kg/day, and the RfD for longer (heavier) chain hydrocarbons ranges from 2 to 6 mg/kg/day. A more conservatively protective RfD value of 0.2 mg/kg/day from the EPA Total Petroleum Hydrocarbon Criteria Work Group (TPHCWG) will be used for TRPH in this HHRA.

SECTION 5

Risk Characterization

Risk characterization is the final component of the risk assessment process, integrating the findings of the previous steps of the HHRA. Risk characterization will involve estimation of the magnitude of potential adverse health effects from exposure to COPCs. Noncarcinogenic health effects and potential excess lifetime cancer risks will be estimated for each exposure pathway for each receptor.

EPA's target range for carcinogenic risk associated with Comprehensive Environmental Response Compensation, and Liability Act (CERCLA) sites of 1 in 10,000 (1×10^{-4}) to 1 in 1,000,000 (1×10^{-6}) will be used as the acceptable risk range. That is, the estimated risk associated with the site should not exceed this target range.

The Hazard Index (HI) approach will be used to determine potential non-cancer health effects associated with COPCs. When the sum of hazard quotient (HQs) for a receptor exceeds unity (one), there may be concern for potential non-cancer health effects, assuming that the cumulative effect of multiple sub-threshold exposures is additive, and may result in an adverse health effect to a particular target organ.

SECTION 6

Uncertainty Characterization

All HHRAs involve the use of assumptions, professional judgment, and imperfect data to varying degrees. This results in uncertainty in the final estimates of risk. The major uncertainties associated with the HHRA will be discussed, including:

- The available data set
- Calculation of EPCs
- Receptors included in the evaluation
- Conservativeness of COPC closure levels

SECTION 7

Project Organization

The Navy Technical Representative (NTR) for the Site-Specific Risk Assessment of the DRMO Building 2009 Area is Mr. Roberto Pagtalunan. Mr. Pagtalunan is the FACLANT representative and provides technical direction on the project and coordinates funding and overall interaction with other agencies and interested parties. Mr. Pagtalunan can be contacted at the address and telephone number listed below.

Mr. Pedro Ruiz and Mr. Hector Nazario are the Public Works Department contacts for NAPR. Mr. Ruiz is responsible for the coordination of DRMO closure sampling activities at NAPR, and Mr. Nazario is responsible for coordination of any possible demolition, construction, or remediation activities at DRMO. Mr. Ruiz and Mr. Nazario can be contacted at the addresses and telephone numbers listed below.

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The JV I Project Manager designated for the management and technical direction of this risk assessment project is Mr. Russell Bowen. Mr. Bowen will be responsible for such activities as technical support and oversight, budget and schedule review and tracking, preparation and review of invoices, personnel resources planning and allocation, and coordination with FACLANT and NAPR. Dr. Vijaya Mylavarapu is the lead risk assessment scientist for the project, and will be JV I technical lead in the performance of the HHRA.

SECTION 8

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